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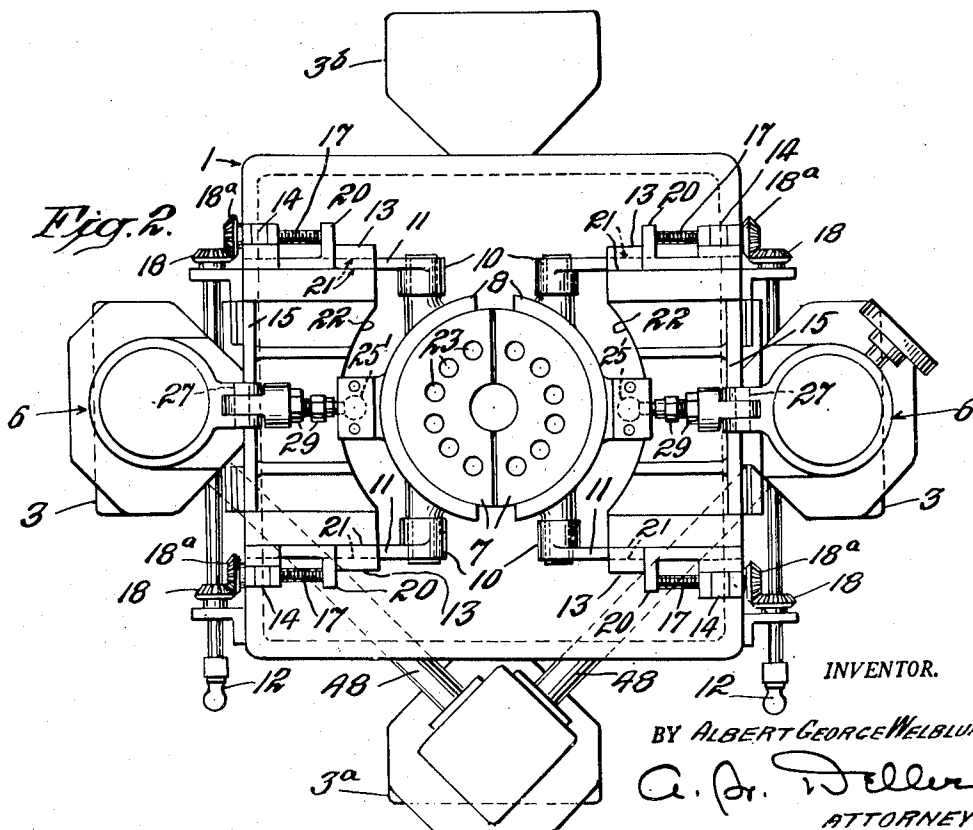
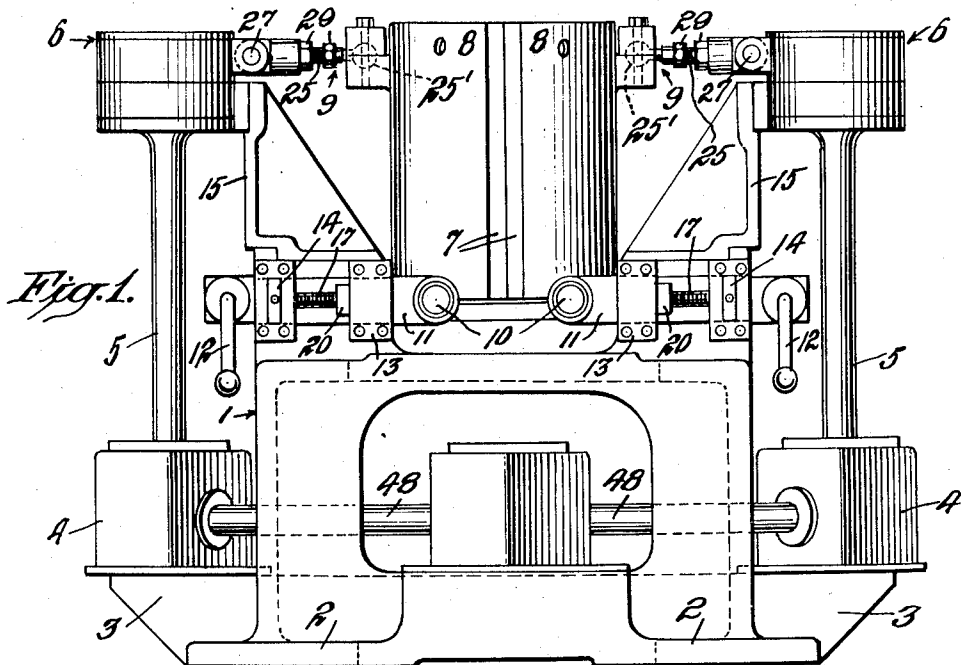
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2,578,213

VIBRATING MECHANISM FOR DYNAMIC MOLD CASTING MACHINES

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2 SHEETS—SHEET 1



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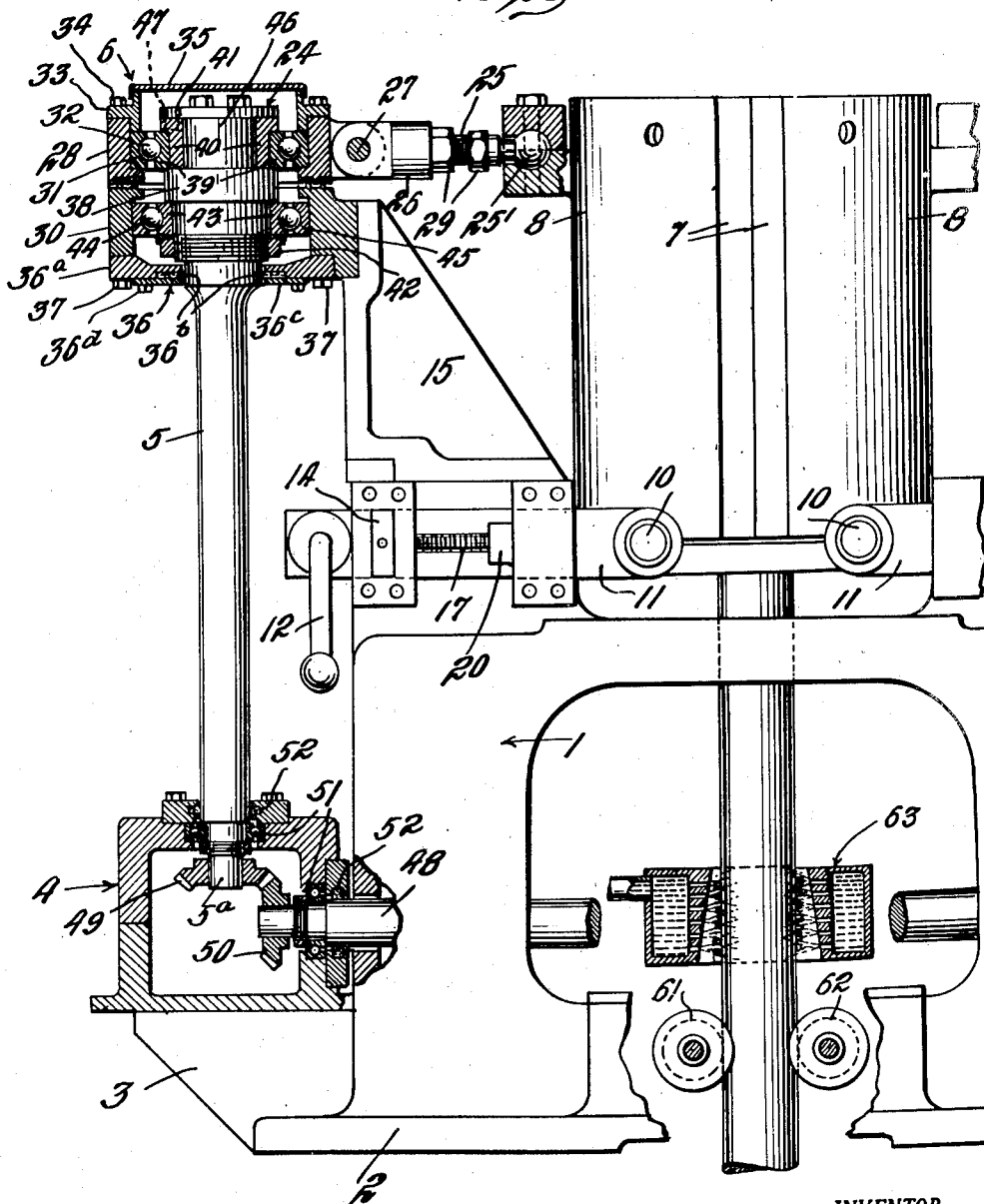
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2 SHEETS—SHEET 2

Fig. 3.



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VIBRATING MECHANISM FOR DYNAMIC
MOLD CASTING MACHINES

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The present invention relates to the art of continuous casting of metals and alloys, and more particularly to an improved structural design and arrangement of a vertically split mold and associated mechanism for the vibrating of the mold sections in a manner to effect a more efficient casting operation.

The present invention contemplates an improved continuous casting machine and method of operating the same in which sticking or adherence of solidified metal to the wall of the mold is effectively prevented by the use of a divided mold whose sections are given a relatively slight but rapid vibration substantially transverse to the direction of motion of the casting or shape.

The present improvements further contemplate a special structural embodiment of a vibratory divided mold adapted for high mechanical efficiency, and having important operational advantages over prior structures, particularly as to reduced wear, improved maintenance of accurate adjustment, greater facility in the cleaning of the mold walls and increased cooling efficiency in the casting operation.

A further object of the present invention is to provide an improved method and means for reciprocating the oppositely positioned, vertically split and mating mold sections for continuous casting in a structural embodiment which will maintain its proper adjustment throughout long periods of operation.

Another object is to provide an improved structural embodiment of a dynamic mold of the type referred to wherein accuracy of the position of the mold sections shall, at all times, be maintained and wherein the amplitude of vibrational movement shall be so controlled as to be uniformly constant with relation to the work.

A still further object is to provide a split sectional mold assembly of a structural arrangement designed to facilitate cleaning of the inner walls as required.

It is likewise within the contemplation of the present invention to provide means for reducing to a minimum the average variation in the cross-sectional dimensions of finished ingots, castings or shapes produced in continuous molding apparatus.

Moreover, the present invention provides an improved method of manipulation or working of the metal during solidification in the continuous casting and offers substantial and important advantages over the prior processes and machines as heretofore employed in continuous casting operations.

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The present invention also contemplates the provision of faster and more efficient cooling of the solidified shapes within the mold cavity.

Important features of the present invention which materially contribute in obtaining the advantages aforesaid comprise a special sectional mold structure having vertically divided sections, each of which is supported at its lower end portion on a pivotal bearing to permit of oscillatory vibrational movement and mechanism for vibrating the sections having articulated connection to the upper end portions of the mold sections. The associated arrangement in operation provides that the amplitude of vibrational movement at the upper part of the mold shall be at its maximum with a decrease gradually towards the lower part of the mold. In consequence, the vibrational working of the metal as it passes through the mold and is progressively cooled therein is with a maximum of vibrational movement at the hotter or entering end of the mold and with a minimum or negligible vibration at the lower or discharge end thereof thus to attain a progressively closer proximity of the metal, as it cools and solidifies, with the mold wall so that better cooling is obtained.

The foregoing and other objects and advantages of the present invention will become apparent from the following description taken in conjunction with the accompanying drawing, in which:

Fig. 1 is an elevational view of a vertically split, sectional mold casting machine embodying the features of the invention;

Fig. 2 depicts a plan view of Fig. 1; and

Fig. 3 illustrates an enlarged detailed elevational view, partly in section, of the improved sectional mold and oscillating mechanism embodying the present invention.

Generally speaking, the present invention comprises a continuous molding machine having a plurality of mating sections forming a vertically-split mold which is provided with means near the upper extremities of the mating sections for vibrating the sections radially to and away from each other and which is provided with cooperating means near the lower extremities of the mating sections for pivotally supporting the sections and for maintaining said lower extremities in substantially constant spaced relationship.

According to the improvement embodying the present invention, each mold section is supported by two ball or roller bearings located one on each side of the section at the lower extremity thereof, and the vibrating linkage is attached to the top of the mold section through a ball and socket

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joint. By this arrangement, an oscillatory movement diminishing in amplitude from the top to the bottom may be imparted to the die sections around the supporting bearings.

Referring now to Figs. 1 and 2, it will be seen that the machine comprises a base pedestal 1 which supports a split mold assembly by means of adjustably mounted pivotal bearings supported at each side on the pedestal casting. Since the embodiment of the present invention is illustrated and described in conjunction with a vertically split mold in which two oppositely disposed mating sections 7 are used, it is only necessary to provide vibration and oscillation to each of the mating sections. For this purpose, the pedestal is provided with feet 2 and shelves or platforms 3, 3-a, and 3-b, and gear boxes 4 are supported on the platforms. Each of the gear boxes 4 is connected to transmit motion to an associated mold section by means of a vertical drive shaft 5 carrying an eccentric head 6 at its upper end with operating connections to a mold section supporting member. It will be apparent that the vertically split mold could be made up of a great number of mating sections, for example, four mating sections, by providing additional gear boxes on the platforms 3-a and 3-b with suitable provision of associated additional eccentric heads.

In accordance with the present invention, yokes 8 constituting movable supporting members for the mating mold sections 7 are articulated with the eccentric heads 6 by some form of suitable universal joint 9. The lower extremities of each yoke 8 are supported at each side thereof in pivotal bearings 10 wherein the lower ends of the yokes 8 and the mating sections oscillate simultaneously with the reciprocation of the upper ends of the yokes. Means are provided for radial adjustment of the yokes whereby the clearance between the mating mold sections at the lower extremity thereof may be increased or decreased, and this means consists of a bearing arm 11 integral with the female half of the rocker bearing 10, a head 20 rigid with the arm, a thrust bearing guide 14 on an adjusting screw 17 having threaded engagement with the head 20 whereby the head may be moved back and forth by means of an operating mechanism consisting of a crank shaft 12 having a bevel gear 18 thereon and a meshing pinion gear 18-a on the shaft of adjusting screw 17. Since the head 20 is welded or otherwise rigidly secured to the bearing arm 11, any movement of the head 20 will produce a corresponding movement in the bearing arm 11 and a corresponding displacement of the yokes 8 and the mating sections 7 will be effected through the rocker bearing 10. Any particular setting of the yokes 8 as made by the radial adjustment means is maintained by means of the guide clamp 13 which is adapted to clamp tightly to the bearing arm 11 and the thrust bearing clamp 14 having a bearing therethrough for the adjusting screw 17. The bearing arms 11 are adapted to slide along a slot 21 in the sides of a cross-base 22 when the adjusting screw 17 is rotated. The cross-base 22 is integral with the base pedestal 1 and also carries vertical brackets 15 which have secured to their upper ends the eccentric head casings to provide rigid bearing support for the upper ends of the shafts 5.

Each of the mating mold sections 7 is provided with cooling channels 23 running vertically there-through as may be seen in Fig. 2. A cooling medium, such as water, is circulated through these cooling channels during the casting oper-

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ation. The efficiency of heat transfer from the hot ingot to the circulating cooling fluid is advantageously affected in the improved machine of the present invention as hereinafter described.

The mating sections 7 of the dynamic mold are vibrated in coordination with each other and, in the closed position, it is preferable that they mate so closely that there is substantially no clearance between them although they preferably do not actually touch. The vibrations may be imparted to the sections in any appropriate manner, such as mechanically, electrically, pneumatically or the like. A suitable mechanical means therefor is shown in Fig. 3. In this figure, rotating eccentrics, indicated generally by the reference numeral 24, are provided on the upper end of shaft 5 within an eccentric head 6 which is supported by roller bearings on the eccentric shaft end. The rotating eccentrics are adapted to impart reciprocating motions to the mating sections 7 through connecting rods 25 and the yokes 8. Each connecting rod is connected at its outer end to an annular member 28 of the eccentric assembly by means of a cross-head 26 pivotally connected to member 28 by a wrist pin 27. The cross-head 26 is provided with a drilled and tapped hole into which a correspondingly threaded end of the connecting rod 25 is screwed. The opposite end of the connecting rod 25 is provided with a balled end 25' which is retained within a socketed projection on the yoke 8 to form a ball and socket joint. A nut 29 provides for locking the rod in its adjusting position. The eccentric head 6 comprises the upper, outer annular member 28 and a lower, rigidly supported bearing housing section 30. The annulus 28 is rabbeted on its inner surface to provide a shoulder on which an outer race 31 of a ball bearing 32 may rest in which position it is firmly held by ring clamps 33 and cap screws 34. Upper member 28 is closed by a cover plate 35 secured to the ring clamp 33. The lower section 30 and upper member 28 are annularly tongued and grooved on their opposed faces, with play being provided between the tongue and groove in amount exceeding the maximum throw of eccentric 24. Upper member 28 is thus free for horizontal movement in any direction but, at the same time, is retained in position relative to the lower housing section 30.

The bottom of lower section 30 is closed by a bottom cover 36 fastened thereto by cap screws 37. The bottom cover preferably comprises a main plate 36-a, a packing ring 36-b which may be of felt, asbestos, rubberized asbestos and the like, and a retaining ring 36-c, all held together by machine screws 36-d. The packing ring 36-b tightly engages the shaft 5 to prevent escape of lubricating agents from lower section 30.

Each shaft 5 is provided with a collar 38 on the upper surface of which the inner race 39 of ball bearing 32 is supported and is retained in supported position by a flanged eccentric ring 40 and a disc 41. Against the lower surface of the collar 38, a lock nut 42 holds an inner race 43 of a ball bearing 44, the outer race 45 of which is secured in any appropriate manner to the inner wall of lower section 30. The upper end 46 of shaft 5, which extends beyond collar 38 is eccentric with respect to the axis of the shaft 5. The inner and outer walls of eccentric ring 40, which fits down over the eccentric end 46, are eccentric with respect to each other. Eccentric ring 40 may be rotatably adjusted with respect to the end 46 and thus the amplitude of the reciprocating motion

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which is imparted to cross-head 26 may be varied. Means for locking eccentric ring 40 in any desired position on end 46 comprises a set screw 47 adapted to be inserted through disc 41 into one of a plurality of holes provided in the top of ring 40. The disc 41 is secured to the end 46 of shafts 5-a by two or more cap screws, and eccentric ring 40 is thus rigidly secured in the described adjusted position on the eccentric end 46 of the shaft 5. Vertical displacement of upper section 28 is also thus controlled.

Rotation of the shaft 5 may be by any appropriate means such as an electric motor (not shown). The motor is arranged to rotate the shaft 48 through any appropriate means. The shafts 5 and 48 are provided with meshing bevel gears 49 and 50 keyed to the respective shafts. These bevel gears and the shaft ends to which they are keyed are enclosed within the gear box 4. The shafts 5 and 48 are provided with suitable bearings 51 and oil seals 52 are also provided to retain gear lubricant with which the gear box 4 is filled.

The machine is put into operation by starting the circulation of cooling water through the cooling channels 23, moving the mold sections 7 to the minimum clearance and introducing molten metal into the mold after first closing off the mold cavity by the insertion of a dummy bar. Adjustment of the eccentric to the desired throw will have previously been made by the radial adjustment means hereinbefore described. The starting dummy bar and following ingot as cast are supported in the customary manner by driven supporting and withdrawing rollers 61 and 62 positioned below the mold assembly and conventionally shown in Fig. 3. Any satisfactory structure may be employed, but it is preferred to use the adjustable pressure structure and arrangement disclosed in U. S. Patent No. 2,284,704, dated June 2, 1942.

It has been found that satisfactory results are obtained by vibrating the mold sections from about 100 to about 1500 times per minute and having them move a very small distance, for example, about two-thousandths to about 50-thousandths of an inch. It will be noted, however, that according to the present invention, this reciprocating movement of the mating sections will take place largely at the upper extremities thereof and with the lower extremities of the mold sections remaining substantially at the setting of minimum clearance. Expressed otherwise, it will be seen that the vibration of the mold sections according to the present invention is a vibrating oscillation thereof from a pivotal support near the lower extremity of each mating section and, hence, varies in magnitude from a maximum throw at the top of the mating section to a minimum of substantially no throw at the lower extremities of the mating sections.

It is to be noted, in the method and machine embodying the present invention, that with the lower extremities of the mating sections remaining substantially at the setting of minimum clearance, the inner wall surfaces of the mold sections are continually maintained in close proximity to the metal of the casting. As a result, there is a marked increase in the efficiency of cooling, with faster cooling and solidification of the shape. The higher efficiency of cooling permits faster operation since, as is well known in continuous casting operations, the rate of input of molten metal and the rate of withdrawal of the solidified ingot must be coordinated, and both are largely

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dependent on the rate of solidification and cooling of the metal within the mold cavity.

The method and machine embodying the present invention produce many advantages over the prior art and likewise provide improved characteristics in the finished ingot. Thus, for example, the following may be cited as illustrative: (1) progressively decreased compression of ingot with solidification; (2) lower mean variation in cross-sectional dimensions; and (3) more efficient cooling of ingot within the mold. Moreover, as shown in Fig. 3, a further cooling of the finished ingot as it emerges from the mold in its passage to the withdrawing rolls is effected by means of water sprays directed against the ingot from the cooling device 63.

Although the present invention has been described in considerable detail with respect to a preferred embodiment, it will be understood that modifications and variations may be resorted to as those skilled in the art will readily understand. Thus, other forms of universal joint for articulating the eccentric head to the mating section and other mechanisms than the crank and bevel gears for adjustment of the rocker bearings are to be considered within the scope of the invention as defined in the appended claims.

I claim:

1. In a machine for molding a continuous ingot, casting or shape of metal and alloys, a cooling mold assembly comprising a plurality of vertically split and mated mold sections providing an open end mold chamber, pivotal bearing supports for mounting each of the mold sections for oscillatory movement about a fixed axis positioned at the lower portion of the sections and means for transmitting an oscillatory movement to the sections.

2. In a machine for molding a continuous ingot, casting or shape of metal and alloys, a cooling mold assembly comprising opposed semi-circular and mated mold sections proving an open end mold chamber, pivotal bearing supports for mounting each of the mold sections for oscillatory movement about a fixed axis positioned at the lower portion of the sections and means for transmitting an oscillatory movement to the sections, said latter means having articulated connection to the upper end portion of each mold section.

3. A machine for molding a continuous ingot, casting or shape of metal and alloys, comprising a plurality of vertically split and mated mold sections providing an open end mold chamber, means for circulating a coolant through the mold sections, pivotal bearing supports mounting each of the mold sections for oscillatory movement about a fixed axis positioned at the lower portion of the section, means for transmitting an oscillatory movement to the sections having articulated connection to the upper portion thereof, at least one of the mountings for the mold sections being adjustably supported for movement relative to the other sections and means operative progressively to withdraw the solidified ingot.

4. A cooling mold structure for a machine for continuous molding of metal and alloys comprising a plurality of mating mold sections formed to provide an open ended mold chamber, pivotal bearing supports for mounting each of the mold sections for oscillatory movement about a fixed axis positioned at the lower portion of the sections, means for transmitting an oscillatory movement to the sections and at least one of said mounting means for the sections being adjustably supported for varying the normal spacing of the sections.

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5. A machine for molding a continuous ingot, casting or shape of metal or alloy comprising an open-ended mold adapted to receive a continuous stream of molten metal into the upper end thereof, said mold consisting of a plurality of sections mating along lines extending from end to end thereof, pivotal bearing supports disposed at the lower extremities of each of said sections for pivotally supporting said sections in mating relationship, reciprocating means having articulated connection to the upper extremities of said sections, means for actuating said reciprocating means for imparting to the sections an oscillatory movement diminishing in amplitude from top to bottom, means for circulating a cooling medium through the sections and means operative to progressively withdraw the ingot.

6. A machine for molding a continuous ingot, casting or shape of metal or alloy comprising an open-ended mold adapted to receive a continuous stream of molten metal into the upper end thereof, said mold consisting of at least two sections mating along lines extending from end to end thereof, adjustable pivotal bearings disposed at the lower extremities of each of said sections for pivotally supporting said sections in mating relationship, rotating eccentric means disposed adjacent the upper extremities of each of said sections, means articulating the mold section upper extremities and said eccentric means operative to impart to the sections an oscillatory movement diminishing in amplitude from top to bottom of the sections, means for circulating a cooling medium through the sections and means for progressively withdrawing the ingot.

7. A machine for casting a continuous ingot or shape of metal or alloy in which a continuous stream of molten metal is directed into an open-ended mold at the upper end thereof and is continuously withdrawn as a solidified ingot from the opposite end, comprising at least two mold sections mating along their vertical edges and formed to provide a mold chamber, means for circulating a coolant within said sections and substantially parallel to the mold surface thereof for abstracting heat from the cast metal to cause progressive solidification of said metal, pivotal bearing supports disposed at the lower extremities of each of said sections for pivotally supporting said sections in mating relationship, reciprocating means articulated to the upper extremities of the sections for imparting an oscillatory move-

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ment to the sections diminishing in amplitude from top to bottom of the sections for maintaining the coolant in progressively closer proximity to the ingot as it proceeds through the mold chamber, and means for progressively withdrawing the ingot.

8. In a machine for molding a continuous ingot, casting or shape of metal or alloy, a cooling mold assembly comprising opposed vertically split and mated mold sections providing an open ended vertical mold cavity, a bearing support pivotally mounting at least one of the mold sections in a horizontal plane and adjacent its lower, discharge end, means operative to transmit movement to said pivotally mounted section to effect continuous and rapid oscillatory movement relative to the mating section during the cooling of the ingot and operative to produce a relative movement between the sections diminishing in amplitude from the top to the bottom of the mold and means for circulating a coolant through the mold sections.

9. A machine for molding a continuous ingot, casting or shape of metal or alloy comprising opposed vertically split mold sections, supports for mounting the mold sections in mating relation to provide an open end molding cavity, at least one of said mold section mountings being adjustable for varying the spacing of the sections, pivotal bearings provided in each of said mold section supports and interconnected with the mold sections substantially in the plane of the lower, discharge ends of said sections to permit oscillatory movement of the sections, means for imparting continuous rapid oscillatory movement to the movable sections during the cooling of the ingot, means for circulating a coolant through the sections, and means operative to progressively withdraw from the mold an ingot, casting or shape.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,284,703	Welblund et al.	June 2, 1942
2,284,704	Welblund et al.	June 2, 1942
2,295,041	Junghans	Sept. 8, 1942
2,376,518	Spence	May 22, 1945